Sensitivity of simulated GPM satellite signals to the selection of WRF cloud microphysics scheme: An orographic precipitation case in OLYMPEX field campaign

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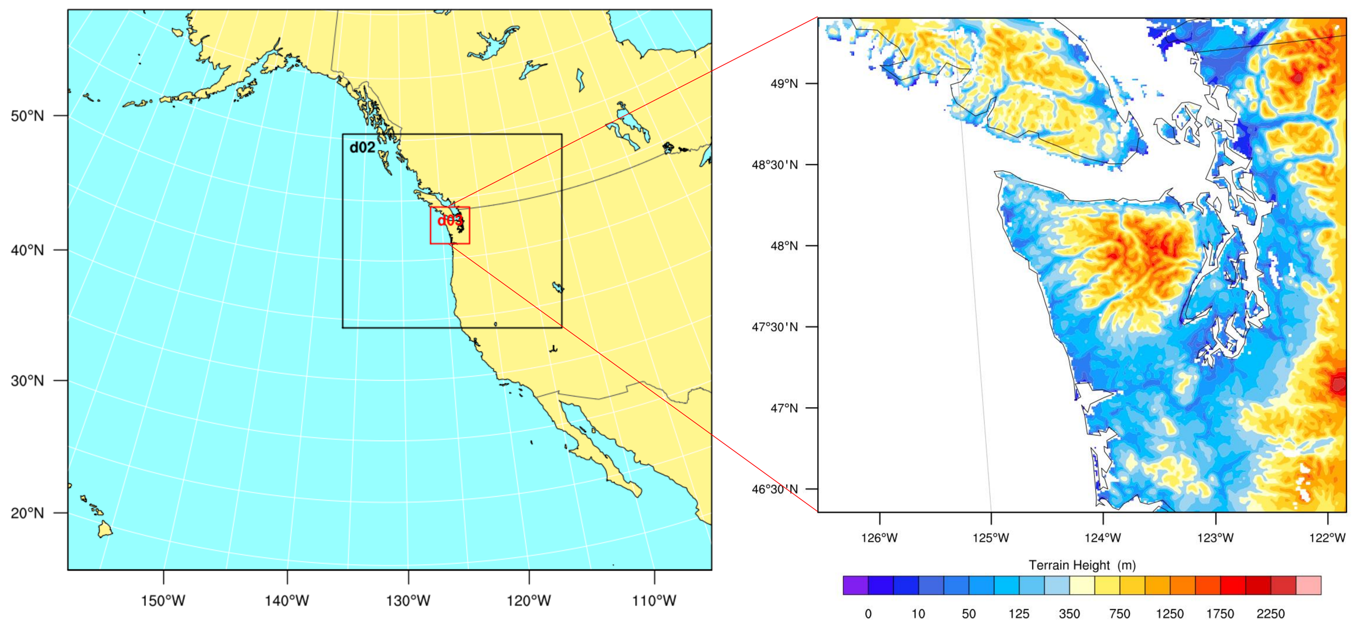
Introduction

Model intercomparison study has been conducted for an orographic precipitation case with an overpass of the Global Precipitation Measurement (GPM) core satellite in the Olympic Mountains Experiment (OLYMPEX) field measurement campaign. Simulations of the Weather Research and Forecasting (WRF) Model with different cloud microphysics schemes coupled to the Goddard Satellite Data Simulator Unit (G-SDSU) are compared with various GPM satellite products, e.g., calibrated GPM microwave imager (GMI) brightness temperature, the Dual-frequency Precipitation Radar (DPR) Ku- and Ka-band reflectivity profiles, GPM Goddard Profiling (GPROF) surface precipitation estimates, and the Integrated Multi-satellitE Retrievals for GPM (IMERG) surface rainfall estimates.

WRF model configurations

Period from 12UTC on Dec 2 to 00UTC on Dec 4, 2015 is simulated. A complex baroclinic system with multiple frontal waves passed through the Olympic mountains region. An orographically enhanced rainfall was observed on the south slopes of the Olympic mountains. The GPM core satellite passed through the region around 1530UTC Dec 3, 2015.



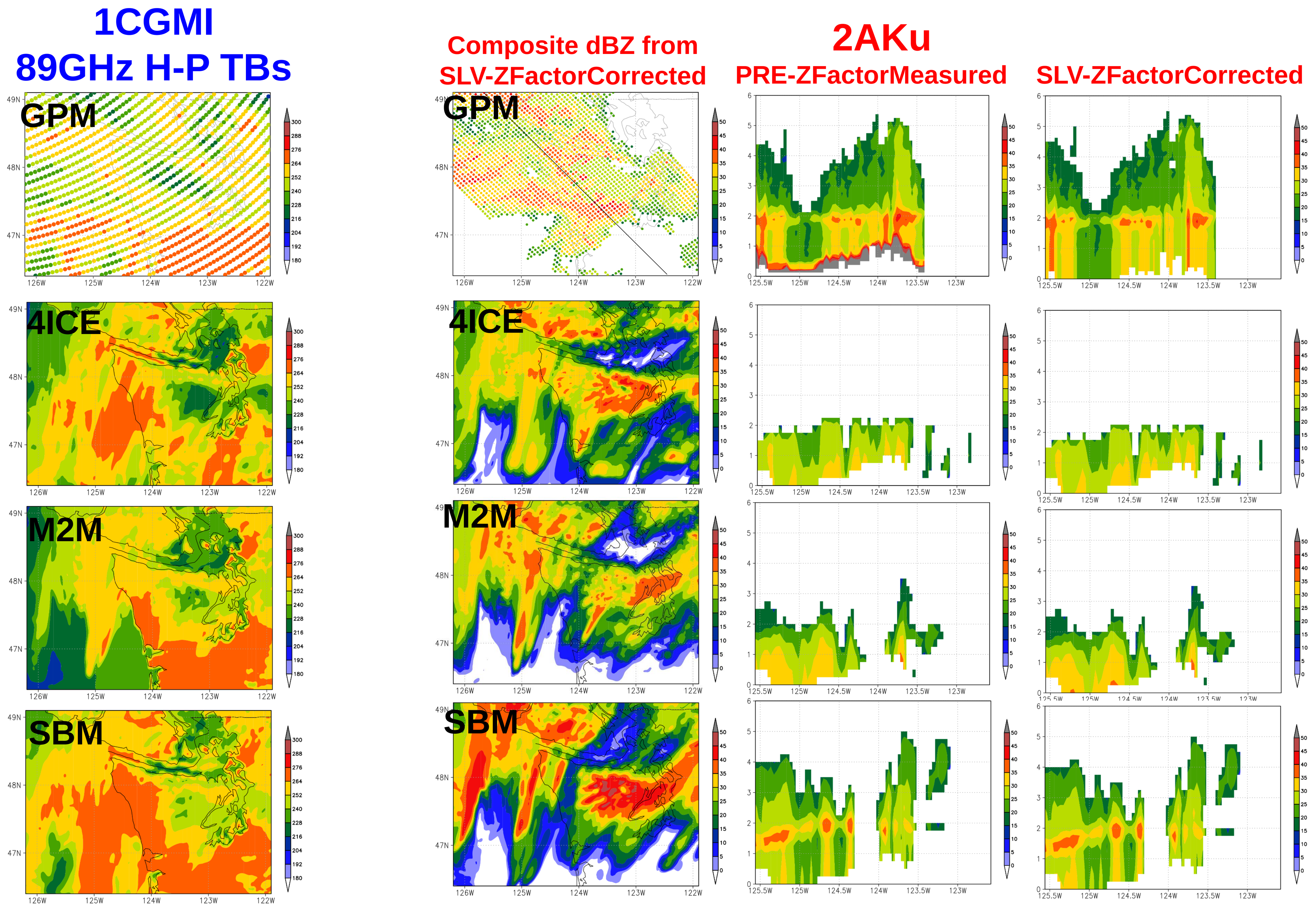
Three nested domain (9km, 3km, and 1km) with 60 vertical layers, and the 1km-domain simulations are mainly analyzed.

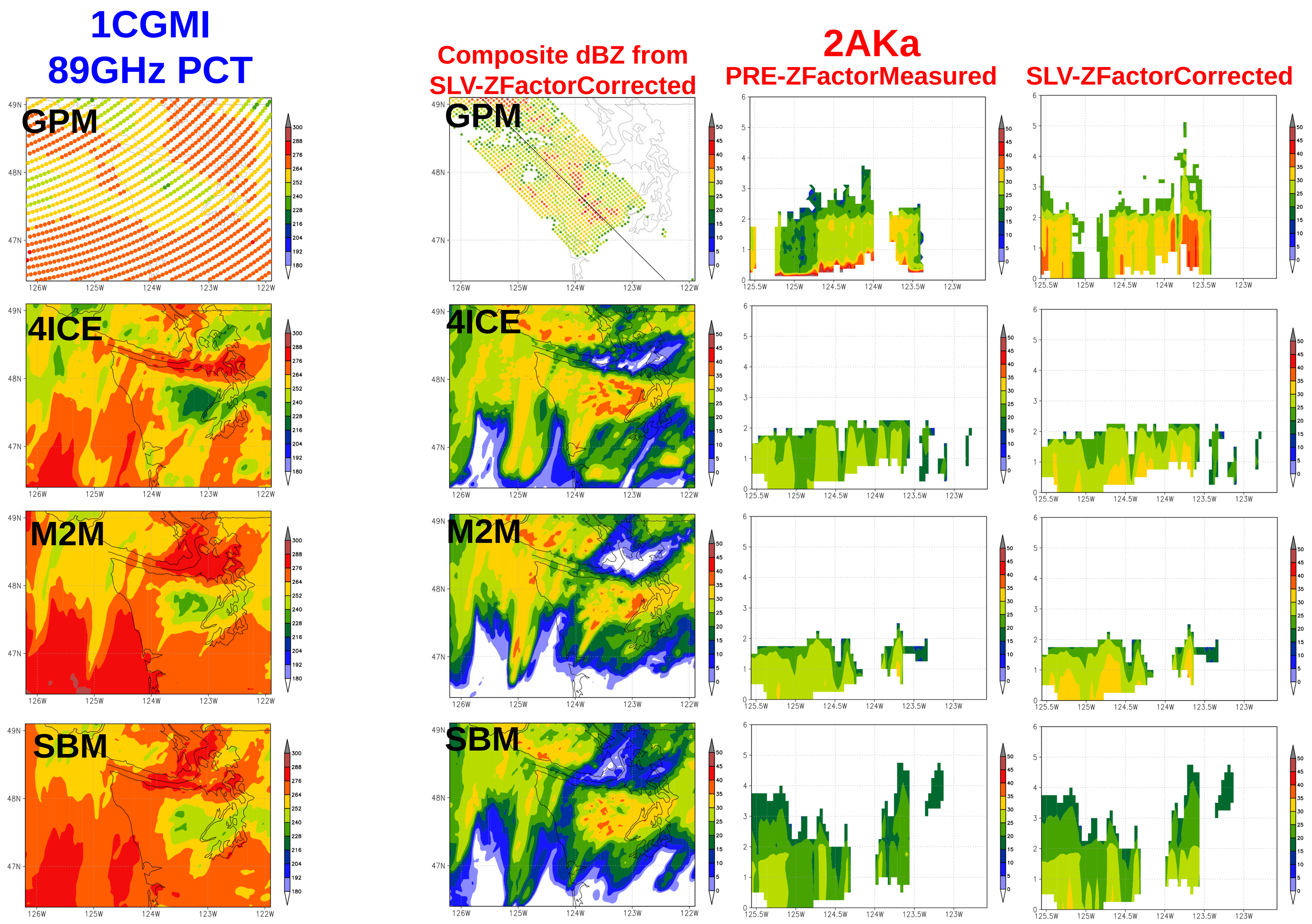
Cloud microphysics schemes:

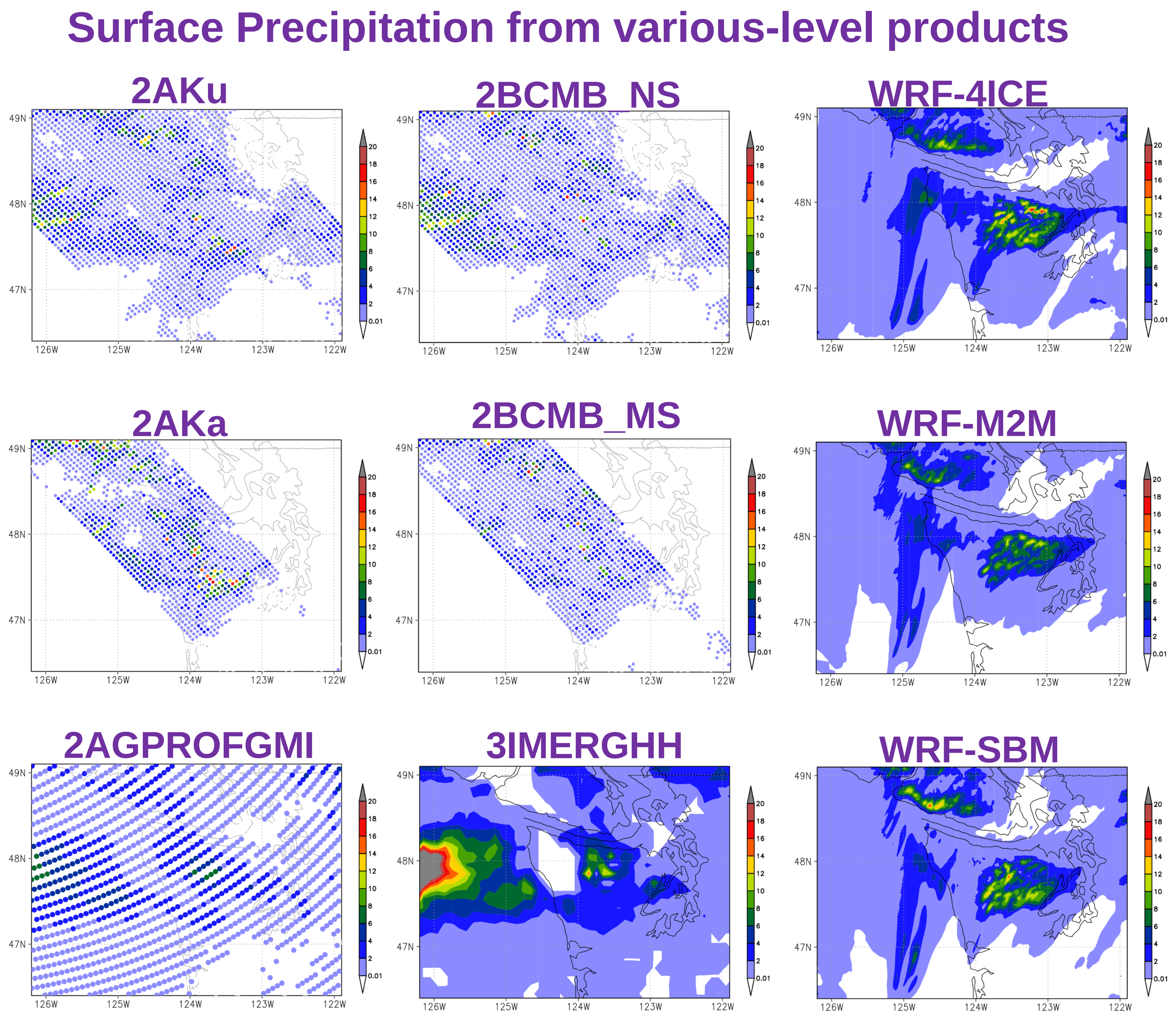
- Goddard 4ICE single-moment bulk scheme
- Morrison double-moment bulk scheme
- Spectral-bin microphysics scheme

Other physics parameterizations:

Goddard Radiation, MYJ planetary boundary layer, Noah surface, Eta surface layer scheme.







Summaries

- 1CGMI observation product shows low brightness temperature (TB) due to high storm top heights by orographic enhancement over high terrain heights area.
- Simulations reproduces the low TB over high terrain heights. The simulation with GCE-4ICE exhibits the lowest TB in the orographically-enhanced part, probably because of smaller particle size assumption of cloud ice.
- 2ADPR (Ku and Ka) observation product seems to miss higher surface rainfall rates and high radar reflectivity over high terrain heights that are estimated by 1CGMI product.
- SBM outperforms GCE-4ICE and Morrison 2-moment schemes in simulations of 2AKu reflectivity, particularly high reflectivity due to bright band effects.
- In contrast, the two bulk microphysics schemes show slightly better performance in simulations of 2AKa.
- All simulations tend to overpredict rainfall amounts over and on the leeward of the Olympic mountains, compared to the various-level products.

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